Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period:\_\_\_\_\_

Why does evolution matter now?: Antibiotic Resistance

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| When people go to the doctor's office, they expect to be cured. They don't like to be told, "Go home, drink lots of fluids and rest, and you will get better." They want a more proactive approach. Often, doctors prescribe antibiotics just to make their patients happy, even if the antibiotics cannot treat the illness at hand. As a result, antibiotics become more prevalent, the microbes they attack are more likely to develop resistance, and over time the antibiotics become ineffective. Learn about why some diseases have become antibiotic-resistant and how you can help address the problem. |
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View "Why Does Evolution Matter Now?" (PBS). Travel inside a Russian prison to see the impact of evolution on the lives of the inmates and the surrounding community. This video describes the transmission of tuberculosis and the evolution of multiple drug-resistant strains of TB.

1. Sicknesses, which are caused by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Microbes are small particles that are able to cause disease in human beings. They include such things as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, mycobacteria, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. And their evolutionary world that they try to survive is inside the human being.
2. What causes tuberculosis? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. (In this video) Where is “ground zero” for the global tuberculosis epidemic? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. How is tuberculosis spread?
5. What are the symptoms of tuberculosis?
6. Treatment begins with one medication. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kills many of the bacteria. A second dose of the antibiotic kills off even \_\_\_\_\_\_\_\_\_\_\_\_\_\_ bacteria, but still some remain alive, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to the antibiotic. If the patient does not take all the prescribed antibiotics, these resistant bacteria \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and pass their resistance to their descendants. In this way a strain of bacteria \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to become fully resistant to an antibiotic

And the same cycle can continue until the person is resistant to all the\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ we use to treat tuberculosis.

It’s a classic example of natural \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Genetic variation within bacteria strains allows some bacteria to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ even when hit by antibiotics. These surviving bacteria are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and continue to evolve, that is survive and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ over time unless treatment is thorough.

A single bacterium can reproduce a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ times in a single human life span.

1. Why should we be concerned if there is drug resistant tuberculosis in Russia?

The Escape of the Pathogens: an evolutionary arms race

Human populations are constantly locked in evolutionary arms races with pathogens that invade our bodies. We must recognize that these pathogens (such as the flu virus shown at right) are continuously evolving entities in order to develop better ways to fight them and control their evolution.

An ounce of prevention...every year?  
Recently, the mayor of New York City called upon citizens to get a head start on one particular evolutionary arms race: "I urge older New Yorkers and others at risk to protect themselves from flu and pneumonia through a simple and proven ounce of prevention: immunizations. The time to get immunized is now, before the peak of the flu season."

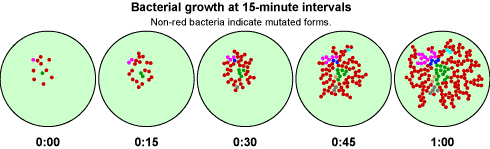
Many of those New Yorkers had already gotten flu shots the year before and the year before that, but, perhaps strangely, they were being asked to get yet another immunization. Why do we need a new flu shot every year? Can't modern medicine invent just one vaccine that would do the trick?



Flu viruses evolve rapidly.  
As they circulate through populations around the world and switch hosts, flu viruses change so much that our vaccines are rendered obsolete every year. The flu is a problem for which a solution must be redesigned and rebuilt every year, like a bridge that gets washed away every flood season. Only by understanding the flu as an evolving entity can we understand why our solution to the problem must change every year.

1. Why does there need to have a new flu vaccine every year?

Rapid reproduction and natural selection  
Because bacteria and viruses reproduce rapidly, they evolve rapidly. These short generation times — some bacteria have a generation time of just 15 minutes — mean that natural selection acts quickly. In each pathogen generation, new mutations and gene combinations are generated that then pass through the selective filter of our drugs and immune response. Over the course of many pathogen generations (a small fraction of a single human lifetime), they adapt to our defenses, evolving right out from under our attempts to rid ourselves of them.



1. Why does natural selection act quickly in bacteria populations?
2. How does variation increase in bacteria populations (2 reasons)?
3. What adaptation allows the bacteria to survive human immune response and drugs?

Applying our knowledge of evolution  
But that doesn't mean that we should stop trying to win these battles. By understanding these pathogens as evolving entities, subject to the same processes of evolution that we can study in fruit flies or the fossil record, we may be able to identify ways to slow their progress.